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OPTOELECTRONIC CHIP FOR THE IMPLEMENTATION OF BACK ERROR PROPAGATION

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We present a CMOS silicon chip that optically implements the back error propagation (BEP) algorithm [1] of a two layer neural network. The chip has eight units (or "neurons") on a area of approximately 2×2 mm. Each unit consists of a phototransistor as the detector, a modulator pad for light modulation, sample-and-hold circuits, and additional circuits necessary to perform the BEP algorithm.

The modulator pad is an exposed metal layer on which voltage may be applied. Liquid crystal is added on top of the chip and covered with a glass plate coated with a transparent conducting film. Light is modulated by applying voltage between the modulator pad and the transparent conductor which changes the polarization of the reflected light (Figure 1) [2,3].

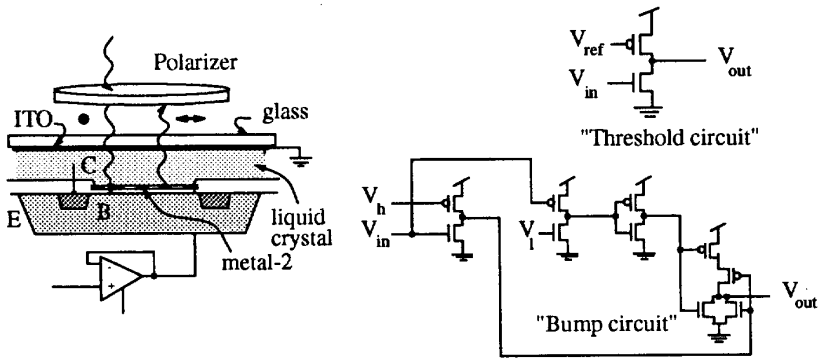

Figure 1. The liquid crystal modulator pad and threshold and bump circuits .

Phototransistors are fabricated directly under the modulator pads that have small openings in order to let light pass through. Two functions are needed to implement the BEP algorithm. These are thresholding in the forward direction and a bump function in the backward direction [1]. The schematic of the circuits that perform these functions are shown in Figure 1. The circuit can be electronically switched between the forward and backward modes. Figure 2(a) shows the measured pad-voltage versus input signal for both the forward and backward responses. Figure 2(b) shows the measured light reflectivity versus pad-voltage. The contrast obtained with this device is about 4:1. Experimental demonstration of the training of a simple network using this chip will be presented at the conference.

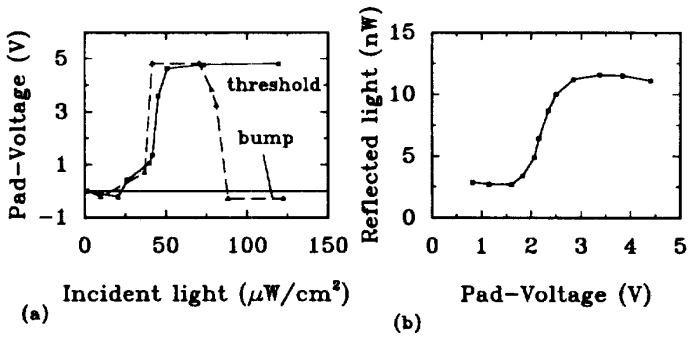

Figure 2. (a) Pad-voltage vs. input signal. (b) Reflected light vs. pad-voltage.

References

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